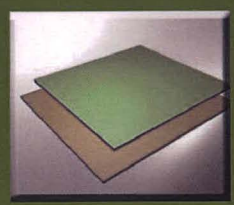
ADVANCES IN COMPOSITE MATERIALS



Iskandar Idris Yaacob
Md Abdul Maleque
Zahurin Halim

IIUM PRESS

INTERNATIONAL ISLAMIC UNIVERSITY MALAYSIA

ADVANCES IN COMPOSITE MATERIALS

Iskandar Idris Yaacob
Md Abdul Maleque
Zahurin Halim

IIUM Press

Published by:
IIUM Press
International Islamic University Malaysia

First Edition, 2011

Perpustakaan Negara Malaysia Cataloguing-in-Publication Data

Iskandar Idris Yaacob, Md Abdul Maleque & Zahurin Halim: Advances in Composite Materials.

ISBN: 978-967-418-231-1

Member of Majlis Penerbitan Ilmiah Malaysia – MAPIM
(Malaysian Scholarly Publishing Council)

Printed by :
IIUM PRINTING SDN. BHD.
No. 1, Jalan Industri Batu Caves 1/3
Taman Perindustrian Batu Caves
Batu Caves Centre Point
68100 Batu Caves
Selangor Darul Ehsan

Table of Content

Chapter 1 1
A Critical Review of Metal Matrix Composite Brake Rotor
Md Abdul Maleque

Chapter 2 7
Technology of Moulding for Composite Auto Brake Rotor
Md Abdul Maleque

Chapter 3 13
Fabrication of Nickel Aluminide (Ni_3Al) by Hot Isostatic Pressing (HIP)
Faizal Abu Zarim, Iraj Alaei, I.I. Yaacob

Chapter4 17
Investigation of Mechanically Alloyed Nd-Fe-B Powder
I.I. Yacoob and H.K. Jun

Chapter 5 23
Synthesis And Characterization Of Nanocrystalline Ni_3Al Intermetallic Produced by Mechanical Alloying And Reaction Synthesis
R.Ismail and I.I. Yaacob[b]

Chapter 6 29
The Effect of Hard Nanofillers on Mechanical Properties of PVC Nanocomposites
Noorasikin Samat, Muhammad Alif Mohd Yusoff and Mohd Shahrul Rizal Bin Zakaria

Chapter 7 34
Fatigue Fracture Mechanism of PVC/$CaCO_3$ nanocomposite
Noorasikin Samat, Alan Whittle and Mark Hoffman

Chapter 8 40
Mechanical Behaviour of Eco Core Composite Sandwich Structure
Norhasnidawani Johari Safiyah Hazwani Abd. Rahim and Zahurin Halim

Chapter 9 45
Characteristics of Oil Palm Biomass via Mixture of Empty Fruit Bunch (EFB) Fiber and Mesocarp Fiber
Zahurin Halim, Nabiha Mohd Noh and Nurshazana Mohamad

Chapter 10 49
Mechanical Behaviour of Oil Palm Empty Fruit Bunch (OPEFB) Albumen-Composites Concrete

Afiqah Omar, Nur Humairah A. Razak and Zuraida Ahmad

Chapter 11 55
The Influence of Biopolymer and Natural Fiber on the Physical and Mechanical Properties of Cement Composite

Norshahida Sarifuddin and Zuraida Ahmad

Chapter 12 62
Thermal and Morphological Study of Biopolymer Cotton-Albumen Clay (BCAC) Composites

Zuraida Ahmad, Teoh Swin Le and Kumaran A/L Samannamuthaliar

Chapter 13 68
Effect of Compaction Time on the Properties of Coir Fiber Reinforced Cement-Albumen Composite

Amir Zakwan Roslin, Nur Humairah A. Razak and Zuraida Ahmad

Chapter 14 74
Oil Palm Empty Fruit Bunch (OPEFB) for Lightweight Composites Concrete

Afiqah Omar, Nur Humairah A. Razak and Zuraida Ahmad

Chapter 15 80
Fabrication of Metal Matrix Composite Automotive Brake Rotor (Part 1)

Md Abdul Maleque

Chapter 16 86
Fabrication of Metal Matrix Composite Automotive Brake Rotor (Part 2)

Md Abdul Maleque

Chapter 17 90
Wear of Aluminium Matrix Composite – Effects of Reinforcement Combination

Md Abdul Maleque and Rezaul Karim

Chapter 18 96
Mechanical Properties of Wood Plastic Composites

Ooi Chong Jin and Shahjahan Mridha

Chapter 19 101
Properties of Wood Fiber Reinforced Polypropylene Composite

Shahjahan Mridha and Nafis Sarwar Islam

Chapter 20 108
The effects of chemical and mechanical treatments on coir fibre to mechanical properties of coir-albumen-concrete

Zuraida Ahmad and Nurizan Omar

Chapter 21 114
Architecture of Chopped Fiber Glass in Plastic Composite Processed Under Different Loads
Ahmed Nazrin Md Idriss and Shahjahan Mridha

Chapter 22 119
Variation of Fiber Architecture on Loads applied in Fabrication of Epoxy/Woven Fiber Glass Composite
Ahmed Nazrin Md Idriss and Shahjahan Mridha

Chapter 23 125
Impact Behavior of Carbon/ Epoxy Composite in Moisture and Temperature environments

Shahjahan Mridha

Chapter 24 132
Impact Strength Behaviour of the Woven and Chopped Fiber Glass Composites at Different Temperatures
Ahmed Nazrin Md Idriss and Shahjahan Mridha

Chapter 25 138
An Investigation of Hybrid Composites Tubes Subjected to Quasi-Static Loading

Farrah Yussof and Zuraida Ahmad

Chapter 26 144
Mechanical Behaviour of Biopolymer Cotton Albumen Clay (BCAC) Composites

Teoh Swin Le, Kumaran A/L Samannamuthaliar and Zuraida Ahmad

Chapter 27 150
The Effect of Processing Parameters on Tensile Properties Empty Fruit Bunch (EFB) Fiber Reinforced Thermoplastic Natural Rubber Composites

Noor Azlina Hassan, Norita Hassan, Sahrim Hj. Ahmad and Rozaidi Rasid

Chapter 28 155
Manganese Doped Hydroxyapatite Powder through Hydrothermal Method
Asep Sofwan Faturohman, Alqap, Iis Sopyan and Nuur Izzati Mazmaa

Chapter 29 161
Synthesis and Characterization of Sol-Gel Method Derived Zinc Doped Hydroxyapatite Powder

Asep Sofwan Faturohman Alqap, Nor Hidayu and Iis Sopyan

Chapter 30 167
Synthesis and Characterization of Nickel Iron–Silicon Nitride Nanocomposite

Iskandar I. Yaacob

Chapter 31 172
Fabrication of Nickel Aluminide Intermetallic-Alumina Nanocomposite

Roslina Ismail and Iskandar I. Yaacob

Chapter 32 178
Investigation on the Effect of Water Immersion on Cotton Albumen Composite

Zahurin Halim, Zuraida Ahmad and Fauziah Md Yusof

Chapter 33 182
Numerical and Experimental Investigation of Peel Strength of Composite Sandwich Structures

Zahurin Halim , Shahnor Basri and Mohd Ramli Ajir

Chapter 34 190
Finite Element Analysis of Interlaminar Stresses in Edge Delamination

Zahurin Halim and Meor Mohd. Adli Taib

Chapter 007

Fatigue Fracture Mechanism of PVC/$CaCO_3$ nanocomposites

Noorasikin Samat[1], Alan Whittle[2], Mark Hoffman[3]
[1]Kulliyyah of Engineering – International Islamic University Malaysia
[2]Iplex Pipelines Australia Pty Ltd, Australia
[3]School of Materials Science and Engineering, The University of New South Wales, Australia

✉ : noorasikin@iium.edu.my ✉

Keywords: Fatigue, PVC, $CaCO_3$, nanocomposites, craze, debonding

Abstract: The effects of nano-$CaCO_3$ particles on the fatigue properties of PVC have been investigated. PVC nanocomposites were fabricated with different content of $CaCO_3$ ranging from 3 – 20 pphr. It was found that the fatigue resistance of the PVC nanocomposites is similar to that of unmodified PVC with no significant deterioration in crack growth rates observed. Fracture mechanism analysis on PVC nanocomposites was studied to understand the interaction between PVC and the nanosized particles during fatigue loadings. Crazing and particles debonding are the main fracture mechanisms. In addition, ligament yielding of the PVC matrix also occurred and was associated with the particle content and stress amplitude.

Introduction

The addition of nanoparticles into neat polymers is observed to improve not only their mechanical properties i.e. impact strength, but also result in differences in the fracture micromechanisms. In general, particle debonding/cavitation are the dominant toughening mechanisms in the nanocomposite specimens. Evidence for this mechanism was seen to occur in PVC-modified with calcium carbonate [1-2]) and in PP modified with alumina [3] and calcium carbonate [4].

It is noted that the cavitation of particles is an effective mechanism for toughening since its occurrence leads to the deformation of the matrix around the nanocomposites [5]. As a result, large amount of energy is absorbed [2]. In addition, according to Xie et al., [1] a strong interfacial interaction between nanoparticles and the polymer matrix would further increase the absorbed energy for crack initiation and fracture propagation which would then result in toughening during impact. A study by Zhao and Li [3] in polypropylene-filled alumina at the crack tip also found that the particle debonding led to the formation of numerous crazes and microcracks around the subcritical crack tip.

Although research in nanocomposites has received considerable attention, very limited works have been carried out on determining the fracture mechanisms of this composite, predominantly in fatigue tests. A study by Zhou et al., [6] of fatigue response of epoxy reinforced with aluminium oxide particles, showed a marked improvement in fatigue